An Estimate of the Global Burden of Anthropogenic Ozone and Fine Particulate Matter on Premature Human Mortality Using Atmospheric Modeling

Supporting Text

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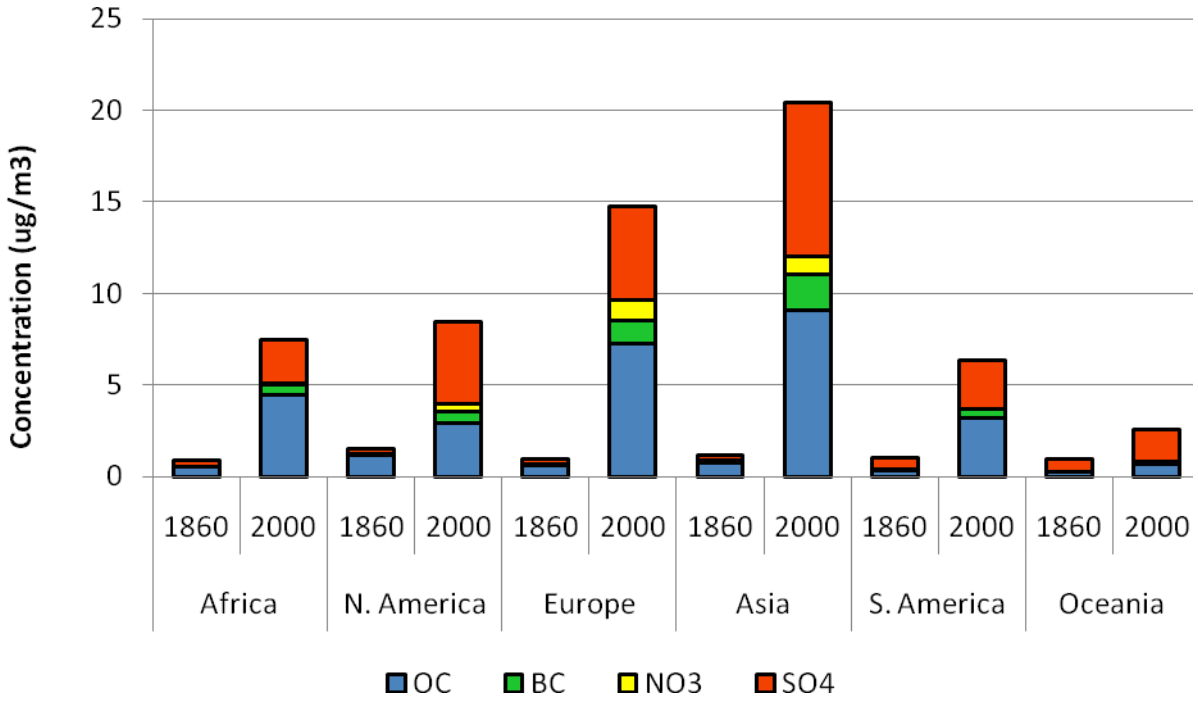
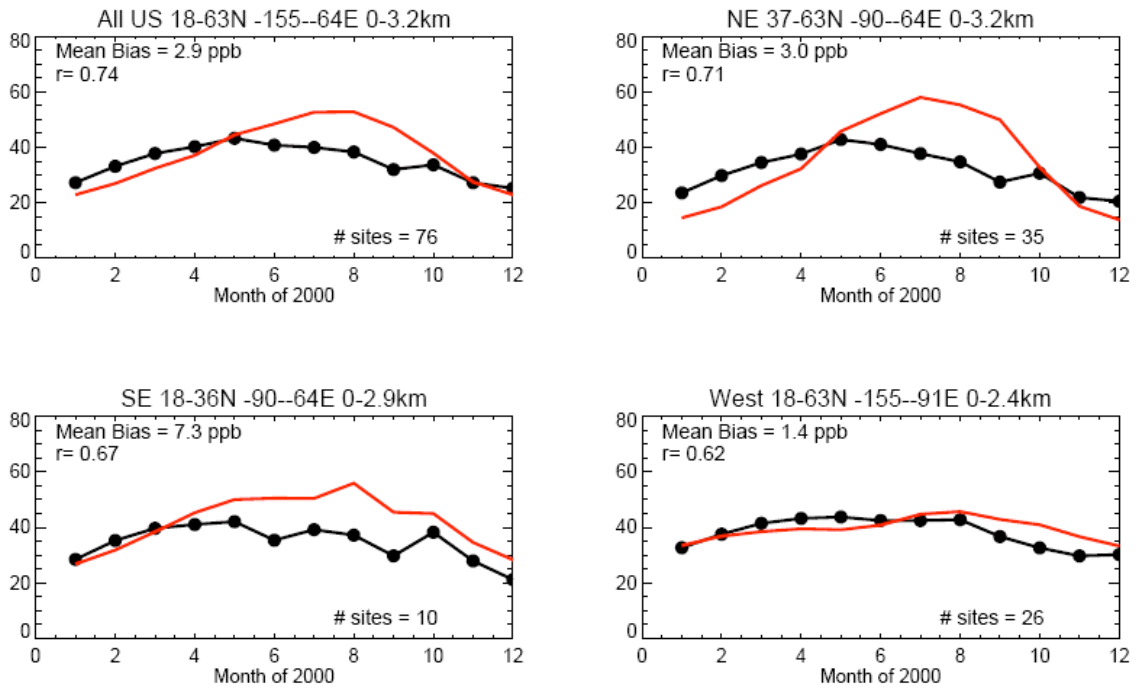


Supplemental Material, Figure 1. Population-weighted annual average $PM_{2.5}$ component concentrations from MOZART-2 simulations of the preindustrial (1860) and present (2000) (Horowitz 2006). NH_4 is included in the values for NO_3 and SO_4, as all SO_4 and NO_3 are assumed to exist as $(NH_4)_2SO_4$ and NH_4NO_3, following Ginoux et al. (2006).

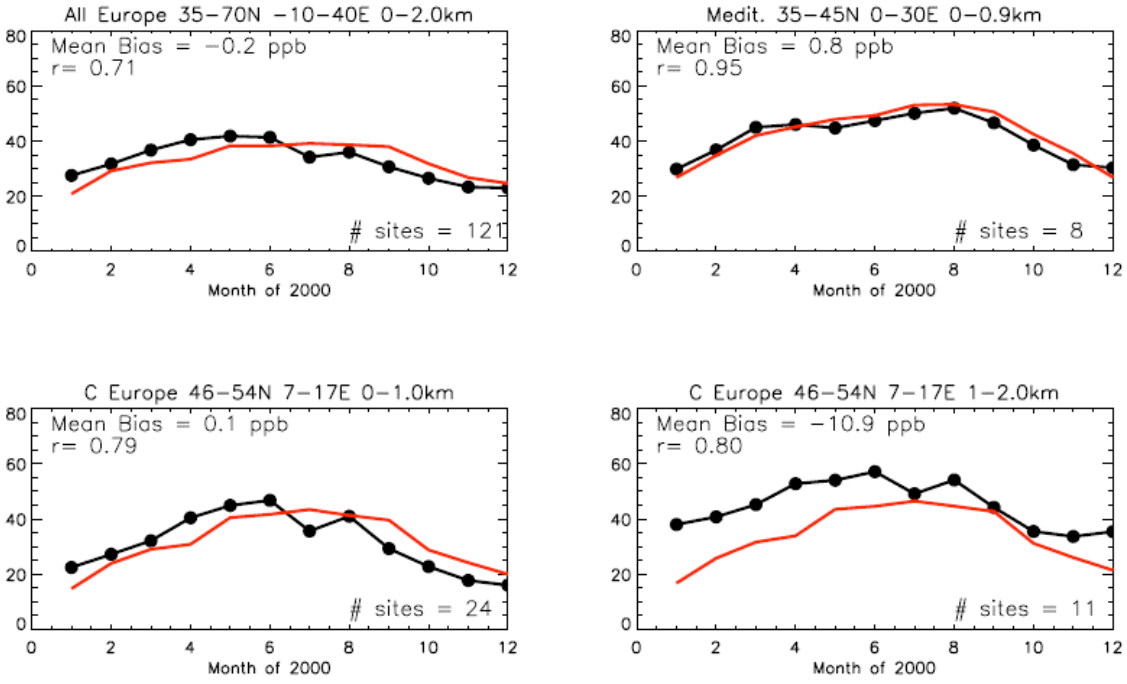
Modeled Surface Ozone Comparison with Observations

We compare monthly mean surface ozone concentrations modeled with the Model of Ozone and Related Chemical Tracers, version 2 (MOZART-2) for the present day (2000) (Horowitz 2006) with observations from three non-urban networks, the Clean Air Status and Trends Network (CASTNet; http://www.epa.gov/castnet/) for the US (Supplemental Material, Figure 2), the European Monitoring and Evaluation Programme (EMEP; http://www.emep.int/)

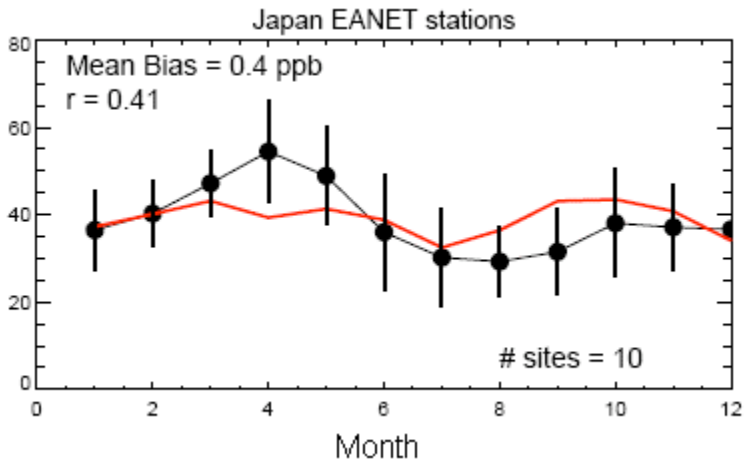
for Europe (Supplemental Material, Figure 3), and the Acid Deposition Monitoring Network in East Asia (EANET; http://www.eanet.cc/) for Japan (Supplemental Material, Figure 4). We also compare surface ozone with the Climate Monitoring and Diagnostics Laboratory (CMDL; http://www.esrl.noaa.gov/gmd/) monitoring network for remote locations around the world (Supplemental Material, Figure 5). CASTNet and EMEP observations are from 2000, EANET observations are from 2001, and CMDL observations are from 1998-2004, depending on data availability. Overall mean bias is 2.9 ppb for CASTNet, -0.2 ppb for EMEP, 0.4 for EANET, and 2.5 ppb for CMDL. Since mean bias is within 3 ppb for all networks, we do not apply a bias correction for the main results, but examine the sensitivity to a concentration change of 25% in both directions. Mortality results change about proportionally with concentration.



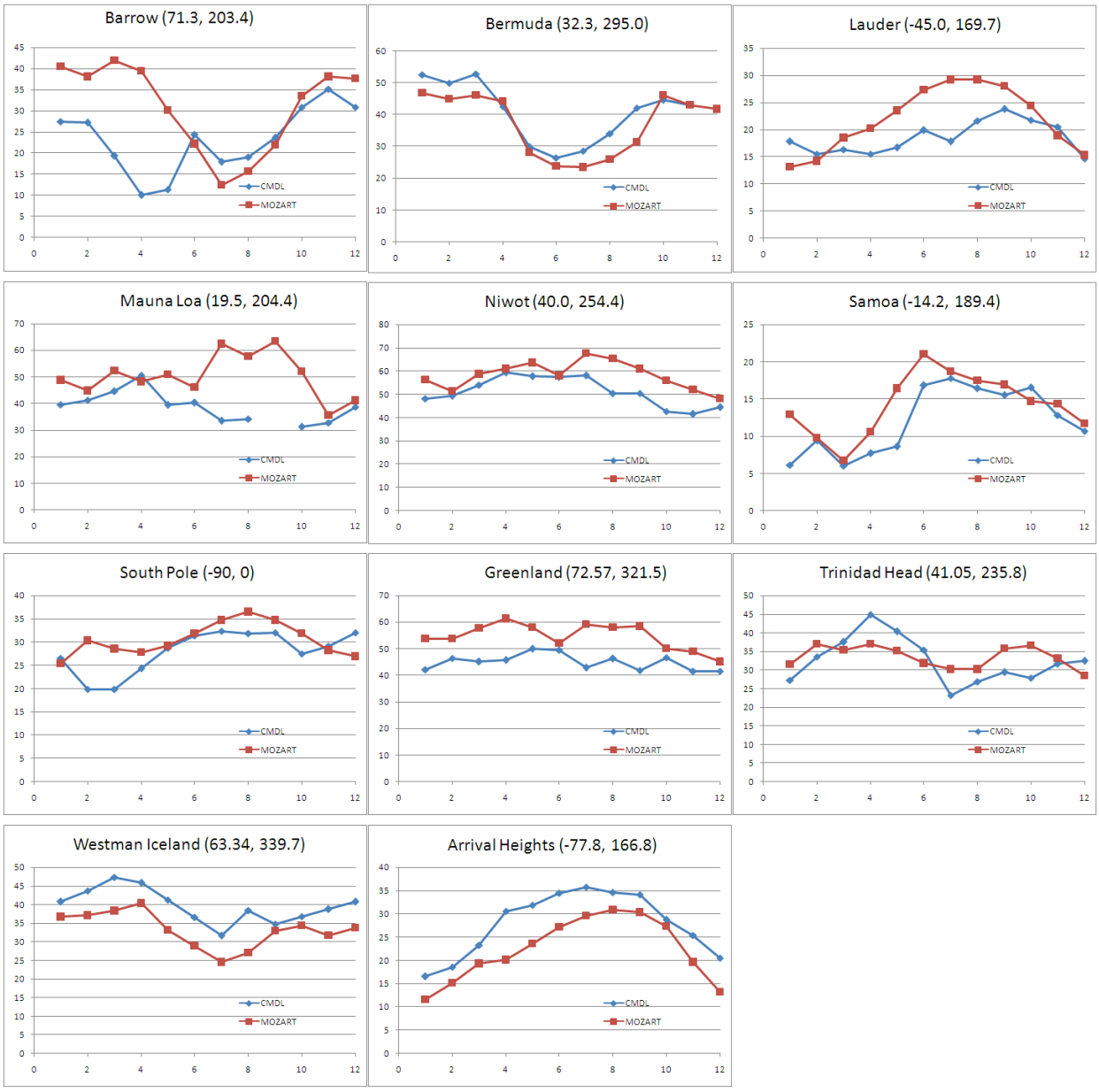
Supplemental Material, Figure 2. Comparison of simulated monthly mean surface ozone concentrations (2000) with CASTNet monitored concentrations (2000) for the entire US and three subregions.



Supplemental Material, Figure 3. Comparison of simulated monthly mean surface ozone concentrations (2000) with EMEP monitored concentrations (2000) for all of Europe and three subregions.



Supplemental Material, Figure 4. Comparison of simulated monthly mean surface ozone concentrations (2000) with EANET monitored concentrations (2001) for Japan.

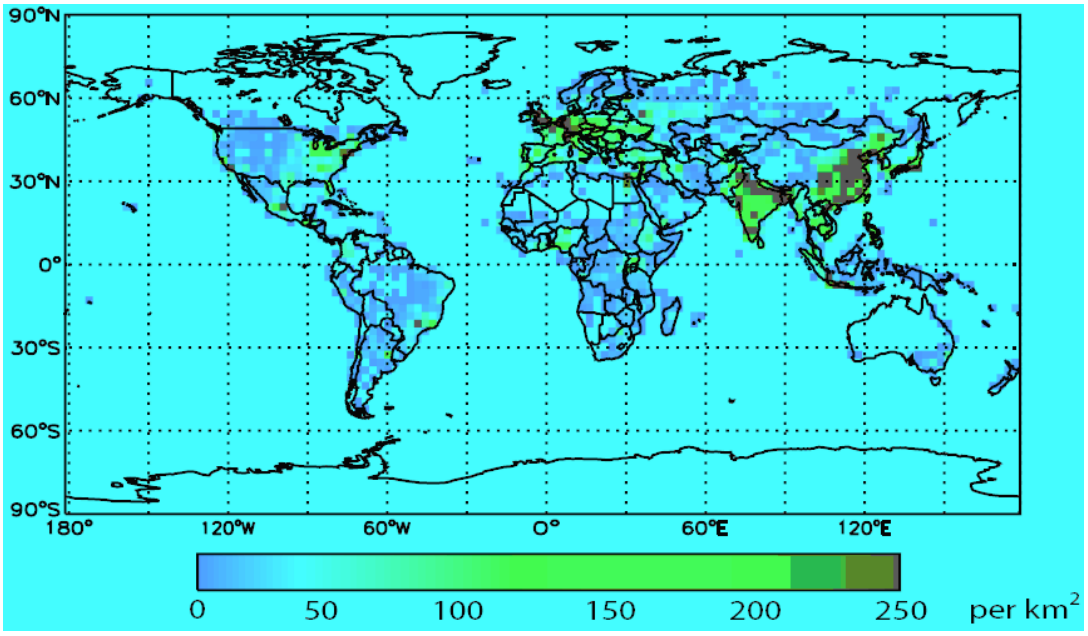


Supplemental Material, Figure 5. Comparison of simulated monthly mean surface ozone concentrations for 2000, in ppb (Horowitz et al. 2006), with CMDL monitored concentrations (1998-2004) for remote locations.

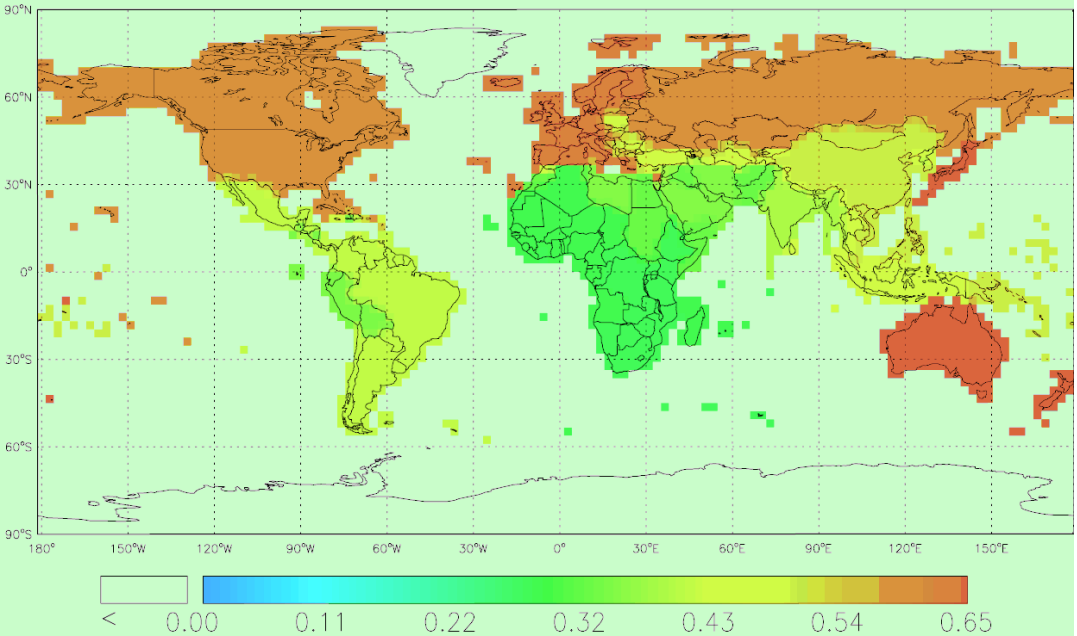
Health Impact Function Input Parameters

Population

We use 2006 population from the Landscan database (ORNL 2008), which apportions population to very fine resolution grid cells (30”x30”) based on nighttime lights, proximity to roads, and other indicators (Supplemental Material, Figure 6). We also use the fraction of the population aged 30 and older for 14 world regions (WHO 2004) to determine the exposed population consistent with Krewski et al. (2009) for $PM_{2.5}$ mortality estimates (Supplemental Material, Figures 6 and 7).



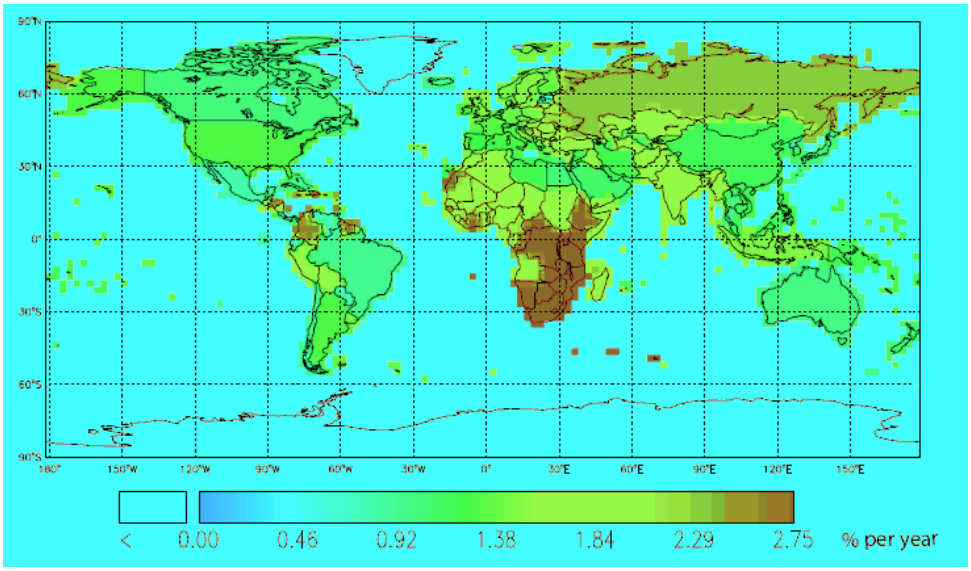
Supplemental Material, Figure 6. Population aged 30 and older mapped on the MOZART-2 grid.



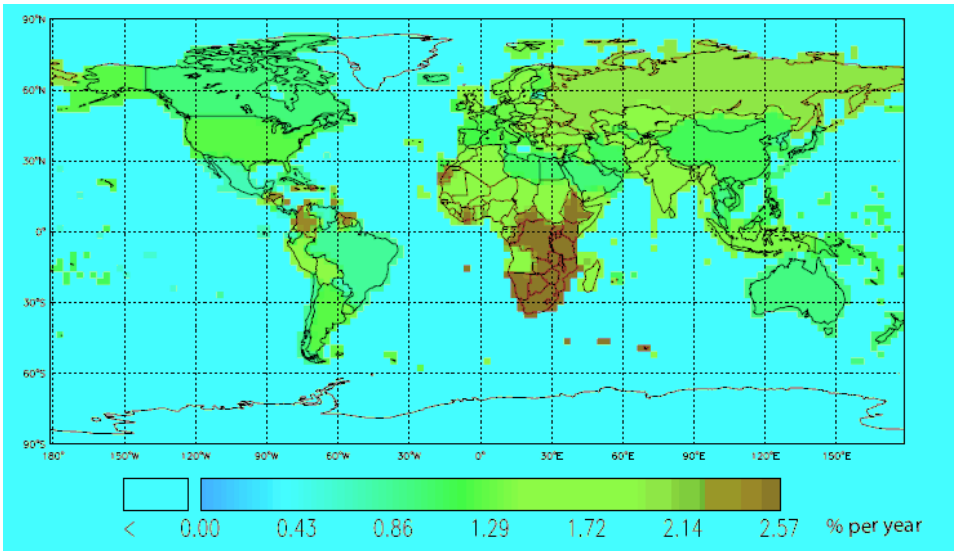
Supplemental Material, Figure 7. Fraction of the population aged 30 and older (WHO 2004) mapped onto MOZART-2 grid.

Baseline Mortality Rates

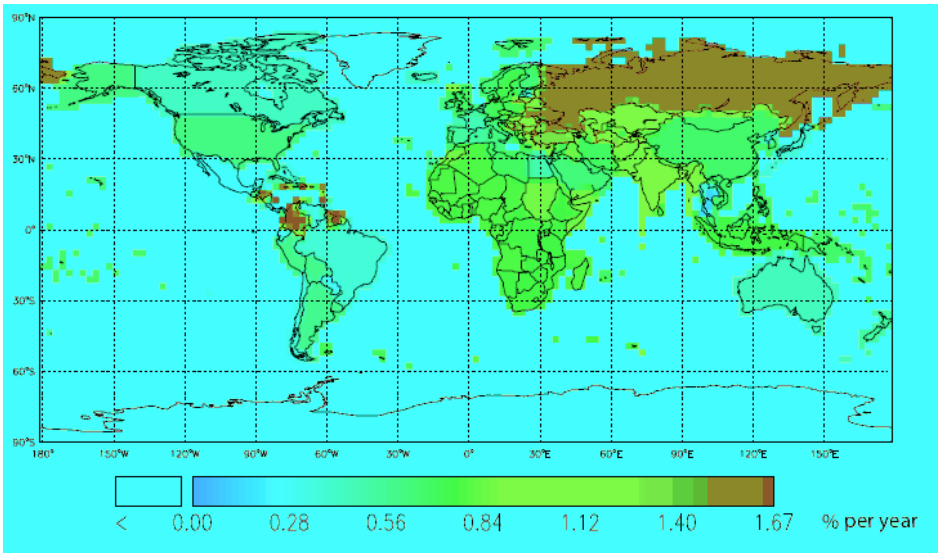
Baseline all-cause, non-accidental, cardiopulmonary, and lung cancer mortality rates for the population aged 30 and older for 66 countries and 14 world regions are from the World Health Organization (WHO 2004, 2008a) and are mapped onto the MOZART-2 grid (Supplemental Material, Figures 8-11). Where country-specific data are unavailable, we back-calculate mortality rates from regional rates. When a grid cell contains portions of more than one country within it, we calculate an area-weighted average mortality rate using a Geographic Information System (GIS).



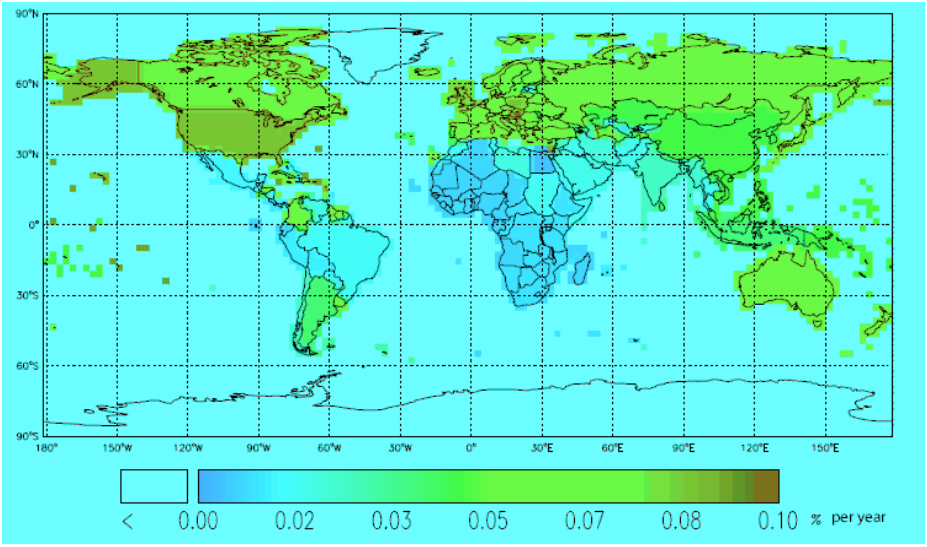
Supplemental Material, Figure 8. Baseline all-cause mortality rates for the population aged 30 and older mapped on MOZART-2 grid.



Supplemental Material, Figure 9. Baseline non-accidental mortality rates for the population aged 30 and older mapped onto MOZART-2 grid.



Supplemental Material, Figure 10. Baseline cardiopulmonary mortality rates for the population aged 30 and older mapped onto MOZART-2 grid.



Supplemental Material, Figure 11. Baseline lung cancer mortality rates for the population aged 30 and older mapped onto MOZART-2 grid.

Supplemental Material, Table 1. Years of life lost per death, using 3% discount rate and age-weighting (WHO 2008b).

	Cardiopulmonary Disease	Respiratory Disease	Lung Cancer
Africa	11.00	14.30	13.43
North America	6.48	8.13	8.92
Europe	7.40	5.93	10.04
Asia	7.98	7.96	10.49
South America	7.61	7.59	9.62
Oceania	5.54	6.97	8.46
World	7.89	8.93	9.77

Supplemental Material, Table 2. As in Table 5.

		All-Cause x 1000	**Cardiopulmonary x 1000**	**Lung Cancer x 1000**
Krewski et al. (2009)		3381 ± 986	3499 ± 864	222 ± 80
	LCT=5.8 $\mu g/m^3$	2378 ± 876 (-29.7%)	2506 ± 816 (-28.4%)	164 ± 68 (-26.1%)
	LCT=7.5 $\mu g/m^3$	2077 ± 822 (-38.6%)	2201 ± 780 (-37.1%)	146 ± 64 (-34.2%)
	HCT=30 $\mu g/m^3$	3059 ± 774 (-9.5%)	3205 ± 676 (-8.4%)	201 ± 68 (-9.5%)
	HCT=50 $\mu g/m^3$	3338 ± 940 (-1.3%)	3464 ± 826 (-1.0%)	219 ± 78 (-1.4%)
Pope et al. (2002) avg.[a]		3378 ± 1516 (-0.0%)	2563 ± 1088 (-26.8%)	221 ± 86 (-0.5%)
	LCT=5.8 $\mu g/m^3$	2375 ± 1209 (-29.8%)	1835 ± 886 (-47.6%)	164 ± 73 (-26.1%)
	LCT=7.5 $\mu g/m^3$	2075 ± 1104 (-38.6%)	1612 ± 815 (-53.9%)	145 ± 68 (-34.7%)
	HCT=30 $\mu g/m^3$	3062 ± 1303 (-9.4%)	2332 ± 944 (-33.4%)	201 ± 75 (-9.5%)
	HCT=50 $\mu g/m^3$	3336 ± 1476 (-1.3%)	2534 ± 1062 (-27.6%)	219 ± 84 (-1.4%)
Pope et al. (2002) 79-83[a]		2333 ± 1196 (-31.0%)	1800 ± 742 (-48.6%)	139 ± 72 (-37.4%)
	LCT=5.8 $\mu g/m^3$	1641 ± 935 (-51.5%)	1289 ± 609 (-63.2%)	103 ± 58 (-53.6%)
	LCT=7.5 $\mu g/m^3$	1433 ± 848 (-57.6%)	1132 ± 562 (-67.6%)	91 ± 54 (-59.0%)
	HCT=30 $\mu g/m^3$	2103 ± 1027 (-37.8%)	1624 ± 627 (-53.6%)	124 ± 62 (-44.1%)

	HCT=50 $\mu g/m^3$	2301 ± 1163 (-31.9%)	1777 ± 720 (-49.2%)	137 ± 71 (-38.3%)
Laden et al. (2006)[b]		7714 ± 2736 (+128.2%)	4549 ± 1439 (+30.0%)	336 ± 198 (+51.4%)
	LCT=5.8 $\mu g/m^3$	5420 ± 2276 (+60.3%)	3208 ± 1236 (-8.3%)	249 ± 156 (+12.2%)
	LCT=7.5 $\mu g/m^3$	4732 ± 2102 (+40.0%)	2796 ± 1151 (-20.1%)	221 ± 142 (-0.5%)
	HCT=30 $\mu g/m^3$	7150 ± 2430 (+111.5%)	4308 ± 1331 (+23.1%)	316 ± 185 (+42.3%)
	HCT=50 $\mu g/m^3$	7651 ± 2685 (+126.3%)	4526 ± 1424 (+29.4%)	334 ± 196 (+50.5%)

[a] Pope et al. (2002) reported relative risk estimates for two time periods (1979-1983 and 1999-2000) and for the integrated average of both. The relative risk estimates for 1979-1983 were more conservative than those from 1999-2000 and the integrated average.

[b] Laden et al. (2006) extended the follow-up of the Harvard Six Cities adult cohort study for eight years, finding significantly higher relative risk estimates for overall mortality than the original study and Krewski et al. (2009)

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